

DEVELOPMENT OF DEEP LEARNING E-MODULE ON HEAT AND TEMPERATURE TO IMPROVE LEARNING OUTCOMES

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Abstract :

This study developed an e-module for deep learning on the topics of temperature and heat to assess the e-module's feasibility, student learning outcomes, and student responses to the e-module. This study employed a research and development (R&D) methodology. The research and development approach was based on the ADDIE model (*Analysis, Design, Development, Implementation, Evaluation*). Product feasibility was evaluated through expert validation; students' cognitive learning outcomes were measured using pretest- posttest assessments; and student responses were measured using a questionnaire. The main gaps identified were that the teaching process remained traditional (lecture method) and the limited development of e-modules that specifically integrate deep learning principles in schools. The results show that the developed deep learning e-module was categorized as highly feasible with a score of 90%. Implementation of the product was proven to improve student learning outcomes, with the average score increasing from 34 to 88 (N-Gain score of 0.8, High Category), and it received an excellent student response rate (87%). This study demonstrates that interactive e- modules applying the principles of *meaningful, mindful, and joyful* learning are an effective digital solution to address learning boredom and improve student learning outcomes.

Keywords: Deep Learning, E-modules, Temperature and Heat

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INTRODUCTION

Education is a basic human need that provides every individual with the opportunity to understand information in depth (Ratnasari & Nugraheni, 2024).mHowever, the reality of education quality in Indonesia currently still faces significant challenges, particularly regarding low student learning outcomes (Alifah, 2021). At the high school level, many students perceive physics as a rather difficult subject. One of the main factors causing this situation is the perception that school subjects, particularly Physics, are difficult to understand. This aligns with the view (Maunino et al., 2023)that Physics is often considered boring because it involves many formulas and abstract concepts that are difficult for students to visualize.

Students often face significant challenges in understanding physics concepts, particularly regarding temperature and heat. The main difficulty encountered is students' inability to distinguish between the definitions of temperature and heat. This is supported by (Yuliana et al., 2019), who found that many students are unable to accurately distinguish between the definitions of temperature and heat, and hold the misconception that any object undergoing a phase change must also experience a

change in temperature. This condition represents a form of misconception that, if left unaddressed, will become a serious obstacle for students in constructing an understanding of more complex concepts in the future. This situation is exacerbated by a teaching and learning process that remains traditional and lacks engaging visuals, causing students to tend to be passive, bored, and unprepared to follow lessons. If this issue is not addressed promptly, students are likely to lose their motivation to learn, ultimately leading to low cognitive learning outcomes (Yuliana et al., 2023). This persistent misconception hinders students from achieving a deep understanding if taught solely through conventional methods (Rizkita & Mufit, 2022). Recent research indicates that many students remain trapped in incorrect intuitive understandings of the transfer of physical energy (Suhaila et al., 2024).

Findings from observations and interviews at SMAN 8 in Bengkulu City indicate that teachers still predominantly use lecture, discussion, and question-and-answer methods, with learning resources limited to printed textbooks or worksheets. The shortcomings of traditional teaching approaches also contribute to a lack of active student engagement, causing students to feel bored and disengaged. This aligns with the findings of (Tubagus et al., 2020), who noted that this traditional approach is a key factor in the lack of active student engagement in the classroom. Despite this, supporting infrastructure such as internet access and policies permitting the use of electronic devices (smartphones/laptops) are already sufficiently available. Teachers state that additional learning media that are more adaptive to technological developments are needed to help students understand complex concepts and improve their motivation and cognitive learning outcomes. Therefore, digital learning tools are needed to motivate students to learn, which in turn impacts learning outcomes. In line with the opinion of (Idayanti & Suleman, 2024), digital-based instructional strategies capable of facilitating deep conceptual change are required.

In the world of education, teaching materials are essential, and one such tool is the module. Modules are a crucial teaching tool for fostering student independence (Rusmulyanti et al., 2022). However, in the digital age, printed modules are considered less interactive due to their limitations in presenting multimedia elements. In contrast, e-modules offer significant advantages because they can integrate videos, animations, and simulations—features impossible to implement in printed modules (Putri et al., 2020). To optimize the role of these e-modules, the integration of a deep learning framework is necessary. Unlike rote memorization, this approach emphasizes meaningful understanding. In line with the views of (Anggraena et al., 2025), the principles of deep learning emphasize that learning is not merely about receiving information, but rather a process of building understanding through *meaningful, mindful, and joyful* experiences.

In practice, these principles of deep learning are implemented through *Problem-Based Learning (PBL)*. The use of PBL-based e-modules is considered highly relevant for temperature and heat topics because this model presents authentic problems from everyday life. This approach helps students connect the abstract concepts of temperature and heat to real-world phenomena through structured investigations. In this way, students are encouraged to find solutions to problems using their own methods (Wulandari et al., 2023). This is supported by the use of the wizer.me platform to create visual and interactive e-modules. This aligns with (Prawijaya et al., 2022), who reported that technology-enhanced learning media can improve students' motivation, engagement, and conceptual understanding in physics. Through active engagement in PBL, students gain a deeper understanding; they do not merely memorize facts but comprehend the underlying principles (Farizi et al., 2023).

The urgency of this research is based on the gap where the development of E-modules that specifically integrate the principles of deep learning on temperature and heat material is still limited and only uses ordinary photos and videos and questions. The novelty of this research lies in the development of teaching materials designed with a deep thinking flow through videos and interactive E-LKPD to encourage students to build conceptual understanding independently and work on questions and E-LKPD directly in the E-Module where teachers can directly see the results of student work. Based on these problems, this study aims to develop an deep learning e-module, see student learning outcomes and student responses to the developed e-module. In the developed E-module using an deep learning approach with temperature and heat material where the class that became the subject of the research was XI 3 SMAN 8 Kota Bengkulu consisting of 33 students. Through this development, it is hoped that the physics learning process will become more efficient and interactive, which in the end will be able to improve the achievement of students' cognitive learning outcomes.

RESEARCH METHOD

Research Design

This study is a research and development (R&D) study which aimed to developing and validating educational products, such as textbooks, educational films, educational applications, and various other forms (Sanjaya, 2013). The development model used is the ADDIE model, which consists of five main stages: Analysis, Design, Development, Implementation, and Evaluation. The use of this model aims to produce an e- module for deep learning that is validated for its validity, practicality, and effectiveness. These stages are presented in Figure 1 below.

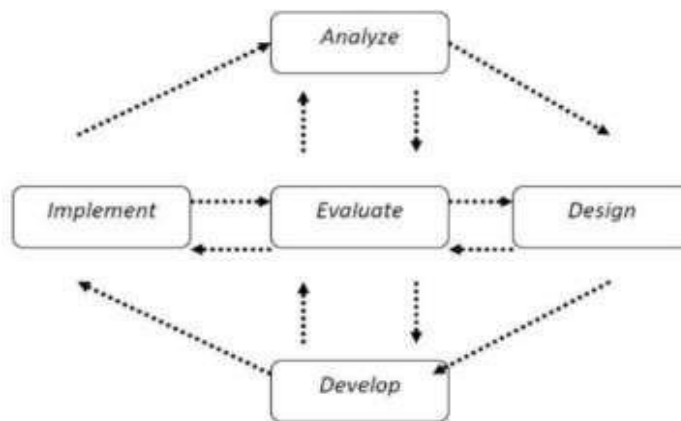


Figure 1. Steps in the ADDIE Research Development Process (Safitri & Aziz, 2022)

The e-module was designed to support student-centered physics learning. To test the effectiveness of the developed e-module, this study employed a one-group pretest-posttest design, in which a single class was assessed before and after implementation without a control group. This design was chosen to identify improvements in student learning outcomes resulting from the use of the developed media within a limited pilot scope.

The e-module was designed by integrating the problem-based learning (PBL) model with the principles of deep learning, including enjoyable, attentive, and meaningful learning. Learning activities were structured using PBL syntax, beginning with orienting students to the problem, organizing students, guiding individual and group investigations, developing and presenting work, and analyzing and evaluating the problem-solving process (Abarang, 2022). These stages are intended to improve students' cognitive learning outcomes. To support interactivity, the e-module provides e-LKPDs to assist students in group work to achieve learning objectives.

Research Subject/Target

This research was conducted in the even semester of the 2025/2026 academic year. The research location was at SMAN 8 Bengkulu City, which was chosen based on considerations of facility readiness and the suitability of the applied curriculum. The availability of supporting facilities such as internet network (Wi-Fi) and access to use of laptops or smartphones for students. This is very relevant to the school policy that has implemented the principle of deep learning, so that the developed module can be immediately applied and is in line with the student's learning style that focuses on a comprehensive understanding of the material. The population in this study included all grade XI SMAN 8 Bengkulu City, with a specific sample of 33 grade XI 3 students. The research subjects involved material experts and media experts who acted as product validators to test the feasibility of the media, as well as grade XI 3 students as product trial subjects to measure learning outcomes using the one-group pretest posttest technique and student responses using a student response questionnaire regarding the developed e-module.

Research Procedure

This research procedure was carried out systematically following the ADDIE model framework. The stages began with Analysis, which is the stage of identifying learning problems at SMAN 8 Bengkulu City through classroom observations and interviews with physics teachers to capture real needs in the field. Next, in the Design stage, the E-Module framework was prepared that integrates the principles of deep learning so that the material is not only memorized but also understood meaningfully. At this stage, the researcher also designed the research structure using a one-group pretest-posttest design to measure changes in learning outcomes before and after using the e-module. The development stage is the process of producing the E-module using the wizer.me platform to ensure its quality, a validation process was carried out by media experts and material experts to obtain suggestions for improvements and ensure the feasibility of the product in terms of video, photos and displays before being tested. At the implementation stage, the research conducted a trial in class XI 3, before using the e-module, a pretest was conducted first after learning to use the E-module on the temperature and heat material, a posttest was conducted to see the students' learning outcomes before and after using the e-module, which then ended with the Evaluation stage. At this final stage, an analysis was carried out on the pretest-posttest value data to see the students' learning outcomes before and after using the e-module as well as a student response questionnaire to measure students' responses to the e-module used.

Data Collection Instruments and Techniques

The data in this study were collected using an expert validation sheet, a student response questionnaire, and a cognitive learning outcome test. The expert validation instrument was used to assess the quality of the content, the accuracy of the physics concepts, the instructional design for deep learning, and the media presentation on the Wizer.me platform. The student response questionnaire was designed to measure users' perceptions regarding ease of navigation, the visual appeal of the e-module, the clarity of the instructional videos, and the usefulness of the media in understanding the concepts of temperature and heat. Meanwhile, the cognitive learning outcome test consisted of 20 multiple-choice questions with five answer options covering the topics of temperature and heat phenomena.

All survey instruments, whether for validators or students, use a Likert scale to minimize bias and encourage clear responses from respondents. Before being used in the implementation phase, all instruments underwent an expert validation process to establish content validity and ensure alignment with the research objectives, learning indicators, and the construct of deep learning theory. The consistency of expert evaluations of the instruments was analyzed using statistical analysis techniques. Testing was conducted via a *pretest* before the use of the e-module and a *posttest* after implementation to quantitatively measure the product's effectiveness.

Data Analysis Techniques

Data analysis in this study was conducted quantitatively. Qualitative data were obtained from observations and interviews, which were then analyzed descriptively to enrich the interpretation of the findings. Meanwhile, quantitative data were obtained from questionnaires completed by expert validators, teachers, and students, which were then analyzed descriptively in the form of percentages. The measurement scales used in this study for media validation employed a 5-point Likert scale, while for the validation of questions and student response questionnaires, a 4-point scale was used. This scale was chosen to avoid neutral responses (central tendency bias) and to encourage respondents to take a more definitive stance in their answers (Purwanto & Risdianto, 2022). Scoring on the Likert scale was assigned weights of 4, 3, 2, and 1. Validation was then conducted by three experts on the E-Module and research instruments. The validation results were analyzed by calculating the percentage of scores for each assessment aspect using the formula:

$$\text{Validity (V)} = \frac{\text{Total score obtained}}{\text{maximum score}} \times 100 \% \quad \dots(1)$$

The data resulting from the calculation using the formula above will yield a value in the form of percentages. Subsequently, the obtained values will be interpreted using the following qualitative categories.

Table 1: Product Feasibility Percentage Scale

Percentage (%)	Score
20% - 36%	Very low feasibility
37%-52%	Unacceptable
53%-68%	Fairly adequate
69%-84%	Suitable
84%-100%	Highly Acceptable

Student learning outcomes were measured through pretest and posttest questions consisting of 20 multiple- choice questions with indicators C3–C4 and five answer choices on the topic of heat transfer. The pretest was administered before the e-module trial, and the posttest was administered after the e-module trial. Improvements in student learning outcomes were analyzed using the N-Gain test with the following formula

$$N\text{-Gain} = \frac{\text{skor Postes} - \text{skor pretest}}{\text{skor ideal} - \text{skor pretest}} \quad \dots(2)$$

To determine students' learning outcomes regarding the developed media. The gain points obtained were then analyzed using the criteria in the following table:
Table 2 N-Gain Index Criteria.

Thresholds	Category
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Moderate
$g < 0,3$	Low

Student responses to the use of e-LKPD were measured through a questionnaire covering aspects of language, appearance, content, usability, and support for self-efficacy. The data were analyzed by calculating the percentage of response scores using the formula:

$$\text{Score Interpretation (\%)} = \frac{\text{Total score obtained}}{\text{Maximum total score}} \times 100\% \quad \dots(3)$$

The data from the calculations using the formula above can then be interpreted as qualitative categories, as shown in Table 3 below.

Table 3 Questionnaire Evaluation Criteria Response

Percentage (%)	Score
25%-44%	Very poor
45%-63%	Poor
64%-81%	Good
82%-100%	Very Good

The learning media developed in this study is a deep learning e-module based on the Wizer.me platform, which can be accessed via computers and mobile devices, according to research conducted by (Purwasi et al., 2024).

RESULTS AND DISCUSSION

This study developed a wizer.me-based deep learning e-module on the topics of temperature and heat to support physics learning and improve student learning outcomes. This product was developed using the ADDIE model and implemented in a limited pilot test to evaluate feasibility, student response, and student learning outcomes. The results are presented systematically, including expert validation, student responses, and improvements in student learning outcomes, and are discussed in relation to relevant theories and previous studies to provide an understanding of the e-module to be developed

Feasibility of the Developed E-MODULE

The e-module validation was conducted through three stages of expert review for product quality. In the first stage, the validator recommended dividing the material into 6 sessions considering

the large amount of material and the relatively large Learning Outcomes (CP), assessed the color and graphics in the e-module, and recommended creating videos/videos from YouTube that were relevant to the learning context to strengthen academic accountability. In the second stage, feedback focused on refining the e-module according to the Learning Outcomes (CP) and Learning Objectives (TP), deepening the in-depth learning context in the module, and correcting incorrect writing or spelling. In the final stage, the validator suggested combining the e-module with the e-LKPD on a single website, namely wizer.me, so that the e-module created would be more practical to use. All feedback was incorporated through gradual revisions, resulting in a more comprehensive and systematic e-module. Validation data was analyzed using equation (1) and the level of feasibility was determined based on the criteria in table 1.

Table 4. E-module validation results

No.	Evaluation Aspect	Number of Items	Result (%)	Category
1.	Content Suitability	4	90	Very worthy
2.	Presentation Standards	2	87	Very worthy
3.	Graphics	2	93	Very worthy
4.	Language	2	91	Very worthy
Average			90	Very worthy

Table 4 shows that the wizer.me-based in-depth learning e-module achieved a very good rating in all assessment aspects, including content suitability, presentation standards, graphics, and language. The validation results achieved an average score of 90%, indicating that all assessment criteria have been comprehensively met. This demonstrates that the developed product has high quality standards as a digital learning medium suitable for use in high school physics instruction, particularly for temperature and heat topics.

The content validity of the e-module, which was rated as highly valid, indicates that the material on Temperature and Heat presented aligns with the Learning Outcomes, learning objectives, content accuracy, and deep learning. This material is systematically organized into sub-sections covering the concepts of temperature and heat, thermal expansion of substances, heat transfer, specific heat and heat capacity, phase changes of substances and latent heat, as well as the Black principle, which are linked to everyday phenomena to reduce misconceptions. This is consistent with the view that effective learning materials must meet curriculum relevance and conceptual depth (Aprilia et al., 2020). Furthermore, with a deep learning approach, students not only memorize information but also evaluate, analyzing and applying concepts in new situations—something that rarely occurs in surface learning approaches (Fauziati, 2025). Deep learning is not merely *rote* memorization (*rote reproduction*), but rather an approach aimed at achieving meaningful understanding (Chen et al., 2024).

The presentation aspect of this e-module is rated as highly satisfactory, indicating that the design of the material presentation is systematic, logical, and easy for students to understand. The design of the material presentation not only focuses on a coherent narrative flow but is also supplemented with supporting elements such as relevant example problems to reinforce a concrete understanding of the concepts of temperature and heat, thereby motivating students in their learning and influencing their learning outcomes. This aligns with the principle that the use of learning media helps increase student motivation, making them more interactive and active in the classroom, thereby providing feedback to educators and teaching staff (Mardatillah et al., 2023). Furthermore, the integration of a deep learning approach in the presentation of this e-module through the wizer.me platform allows abstract material to be visualized in a more engaging way, thereby fostering meaningful learning experiences. According to (Dari et al., 2025). systematic and interactive presentation strategies have been proven to enhance the appeal and effectiveness of the knowledge transfer process compared to conventional media.

From a graphic design perspective, the e-modules developed using the wizer.me platform are considered highly effective, reflecting appropriate visual design elements (layout, color, font); the e-modules are visually appealing, do not interfere with reading comfort, and incorporate images that support understanding of the material, thereby motivating students to learn. According to (Herawati & Muhtadi, 2018), the use of e-modules has been proven to increase student engagement and motivation

in learning, thereby contributing to improved student learning outcomes. This e-module integrates various interactive features such as instructional videos, illustrative images, and E-LKPDs designed to support a deep learning approach. This aligns with the findings of (Putri et al., 2020). These interactive features offer a significant advantage over conventional printed modules in visualizing the microscopic concept of heat.

The language aspect also received a "very satisfactory" rating, indicating that the instructions, concept explanations, and narratives in the e-module are communicative and appropriate for the cognitive development level of high school students. The use of clear and straightforward language has been proven to help students understand abstract physical terms, thereby reducing cognitive load and supporting self-directed learning. This aligns with research (Anggoro, 2023), which emphasizes the importance of clear instructions in digital media for building students' confidence when completing independent tasks.

The implementation of a deep learning approach in this e-module facilitates the creation of *meaningful*, *mindful*, and *joyful* learning experiences. Through the features in the e-module, students are encouraged to connect new information with their prior knowledge through in-depth exploration and investigation of physical phenomena (Fitriani & Santiani, 2025). These activities focused on deep understanding require students not only to memorize formulas but to construct their own thinking independently. The integration of Canva's aesthetically designed media with these deep learning strategies significantly contributes to students' achievement of cognitive learning outcomes, while simultaneously creating a more efficient and enjoyable physics learning environment. According to (Hijrah et al., 2021), Canva supports collaborative learning and helps enhance students' collaboration skills.

The e-modules developed using the Canva app were found to be highly practical and engaging by the students. Therefore, the e-modules were designed using Canva to attract students. This platform provides structured activities, videos, images, and digital worksheets to support the implementation of the Problem-Based Learning (PBL) model and the principles of deep learning. The researcher also emphasizes that the attractive visual design and multimedia integration in the e-module make learning more enjoyable and help students understand the material more deeply. Each learning activity begins with a contextual real-life problem, followed by visual aids such as short videos to facilitate conceptual understanding and reduce the abstraction of dynamic concepts.

Each learning activity begins with a contextual problem related to real-life phenomena involving temperature and heat, followed by visual aids such as short videos or images. This design stimulates students' curiosity, facilitates conceptual visualization, and reduces the abstract nature of the concepts of temperature and heat, thereby improving students' learning outcomes. During the orientation phase, students are presented with authentic phenomena related to the topic of Temperature and Heat, aimed at sparking curiosity and challenging their prior understanding—this constitutes the initial step of the PBL model. This aligns with (Siswanti 2023), the characteristics of deep learning that emphasize active cognitive engagement from the outset of learning to minimize misconceptions that frequently occur regarding the concepts of heat and temperature.

Furthermore, in the stage of organizing students for learning, the e-module provides conceptual reinforcement materials and guides students to work in groups using interactive E-LKPDs to create a *mindful* learning atmosphere. During the guiding investigation stage, students are facilitated with simulation features and videos to conduct independent investigations that promote *meaningful* knowledge construction. The developing and presenting results stage involves visually and interactively constructing problem solutions within the e-module platform, leading to the analyzing and evaluating problem-solving process stage. In this final stage, student success is measured through group formative assessments and individual summative assessments equipped with *real-time feedback* features, allowing students to instantly reflect on their learning process in a *joyful* atmosphere. The e-module can be accessed through this link <https://app.wizer.me/learn/1BJZ8U>

Improving Student Learning Outcomes

Learning outcomes are determined by the quality of the learning process because learning outcomes are abilities or skills possessed by students through learning activities (Djonomiarjo, 2019). The success of implementing in-depth learning e-modules in improving these abilities can be seen *DEVELOPING DEEP LEARNING... (Putri et al.) pp:298-309*

through descriptive statistical analysis and N-Gain score acquisition. Student learning outcome data obtained from pretest and posttest scores were analyzed descriptively to obtain a general overview of the data distribution. A summary of descriptive statistics for student learning outcomes is presented in Table 5.

Table 5. Descriptive Statistics

Descriptive Statistics	Pretest	Posttest
Number of Students (N)	32	32
Minimum Score	15	75
Maximum Score	55	100
Mean	34	88
Standard Deviation	11	7
Variance	121	49

Based on Table 5, there is a significant increase in the average value from 34 to 88. The decrease in the standard deviation from 11 to 7 shows that the use of e-modules not only increases the class average, but also equalizes student understanding (reduces the ability gap). To see student learning outcomes, the N-Gain formula is analyzed as presented in equation (2) which is presented in Table 6 below:

Table 6. N-Gain

Average Before using the e-module	Average After Using the e-module	N-Gain	Category
33,63	87,57	0,81	High

Significant improvements in student learning outcomes have been achieved. Data analysis shows that the average *posttest* score of 88 represents a significant increase compared to the *pretest* score of 34. This is further supported by an *N-Gain* score of 0.81, which places the effectiveness of the e-module in the High Category. The use of Canva's design tools makes the e-module more visually engaging, while the Wizer.me platform enables interactive learning activities. Through this e-module, students can directly watch videos, view images, complete practice exercises, and fill out digital worksheets using devices such as smartphones or laptops. This makes the learning process more interactive and enhances student motivation, ultimately impacting learning outcomes. Additionally, from the submitted work, teachers can easily and quickly review students' answers, particularly for multiple-choice questions, whether correct or incorrect. These findings indicate that approximately 81% of the maximum potential for improvement in students' cognitive understanding has been achieved following the intervention. Referring to Hake (1998) the *N-Gain* value above 0.70 reflects strong instructional effectiveness and is capable of producing a tangible positive impact on academic achievement. Although showing substantial improvement, these results must be interpreted critically. Given that this study employed a one-group pretest-posttest design, there is a possibility that external factors beyond the media, such as students' intrinsic motivation or additional classroom interactions, may have also influenced learning outcomes. Furthermore, the average posttest score approaching the upper limit of the measurement scale (88) indicates an improvement in student learning outcomes, suggesting that the use of media consistently helps students exceed the minimum proficiency threshold for the topics of temperature and heat.

The success of this improvement in learning outcomes stems from the instructional design of the e-modules using the wizer.me platform, which integrates the principles of deep learning. Through multimedia features such as instructional videos and interactive simulations, students can explore concepts independently. This creates a meaningful learning experience, where students do not merely memorize formulas but build a deep, physical understanding of the phenomena of temperature and heat. In line with the theory (Fauziati, 2025), the deep learning approach ensures that students not only recall information but also evaluate, analyze, and apply concepts in new situations—something rarely achieved in surface learning approaches. Furthermore, the use of the Canva platform provides aesthetically pleasing and interactive visual support, thereby fostering a mindful and joyful learning environment. This strategy is effective in reducing cognitive load and overcoming boredom, which often act as barriers in traditional physics learning. Thus, the integration of the deep learning approach

into this e-module has proven to be an effective alternative solution for improving students' cognitive learning outcomes in the digital age.

Student Responses to the E-Module

Student response refers to the social reaction students exhibit in response to influences or stimuli from situations created by others (Kartini & Putra, 2020). In addition to measuring improvements in learning efficacy, this study also analyzed students' responses to the use of the deep learning e-module based on the Wizer.me website. A student response questionnaire was administered after the learning process to gather student feedback on the e-module's visual design, presentation, language, and benefits. Data from student responses to the e-module were processed using Equation (3) and then categorized based on student performance assessment criteria (Table 3). The results are presented in Table 6.

Table 6. Student Response Results

No.	Assessment Aspect	Question	Results (%)	Categories
1.	View	3	94	Excellent
2.	Presentation	10	87	Excellent
3.	Language	4	83	Very Good
4.	Benefits	10	85	Very Good
Average			87	Very Good

An analysis of the practicality of the media was conducted to determine user responses to the developed e-module. Based on data from the distribution of response questionnaires to 11th-grade high school students, an average percentage of 87 was obtained. Referring to the questionnaire evaluation criteria (Andini et al., 2023), this result places this deep learning e-module in the "Very Good" category. This high score indicates that the developed e-module is not only theoretically sound according to experts but also highly practical and easy for students to use in both independent and group learning processes.

The high level of positive student response was influenced by several strengths of the medium. First, the use of the wizer.me platform provided engaging visualizations, harmonious color schemes, and an ergonomic layout, making students enthusiastic about learning the material on temperature and heat. This aligns with the findings of (Hervani et al., 2025), which state that contextual learning can foster student creativity and innovation. Through this aesthetically integrated visual design, this e-module has proven effective in reducing student boredom with physics material often perceived as difficult while simultaneously fostering their critical thinking skills.

Second, the integration of multimedia features such as instructional videos and interactive digital worksheets facilitates *Meaningful Learning*. Students find it helpful to visualize abstract concepts, such as heat transfer via convection and radiation, through the available animations (Adiati Christin et al., 2023). The ease of navigation and accessibility of the e-modules via students' *smartphones* or laptops also provide high learning flexibility (Farawansah & Tarunasena, 2022). Positive responses indicate that students feel interested, motivated, and assisted in understanding the material, while negative responses indicate weaknesses in the media used (Musyarofah & Zahro, 2024).

This study makes a significant contribution to the field of physics education and instructional technology through the integration of deep learning principles encompassing aspects of meaningful, mindful, and joyful learning into the design of interactive e-modules. The novelty of this study lies in the utilization of the Canva and Wizer.me platforms, which do not merely function as static graphic design tools but are developed as an integrated digital environment to present e-modules and e-LKPD interactively in a single functional unit. This finding extends the application of meaningful learning theory to a digital context by providing empirical evidence that technology-based e-modules are able to facilitate strong cognitive construction, as reflected in the N-Gain score of 0.81, which is in the high category, and the very positive student response reaching 84.70%. Practically, this study proposes a scalable, flexible, and easily accessible teaching material model for implementing interactive digital modules in physics learning, thus strategically supporting the digital transformation of quality education at the high school level.

Although this study demonstrated significant effectiveness, there are technical limitations inherent in the wizer.me platform, which limits answer submissions to only one per account. This situation results in a longer processing time for the remaining users, due to the lack of a feature to correct or change answers that have been officially submitted to the system. However, this limitation does not hinder the teacher's instructional role but rather adds value to the objectivity of learning outcome evaluation. Through this single submission system, teachers can obtain

CONCLUSION

This study successfully developed a Deep Learning-based e-module on temperature and heat that significantly improved students' cognitive competence and active engagement in the learning process. This success stems from the integration of meaningful, mindful, and enjoyable learning principles that enable students to construct a deep and independent understanding of concepts, beyond simply mastering technical formulas. The study's primary contribution lies in transforming instructional design using the Wizer.me and Canva platforms, creating an interactive digital learning ecosystem while expanding the application of meaningful learning theory to a digital context. Practically, this e-module offers a scalable and flexible teaching model for teachers to address the abstraction of physics material at the secondary school level. While demonstrating strong effectiveness, this study suffers from limitations in the platform's one-way answer collection system, which limits the flexibility of students' independent revision during the learning process. Therefore, future development should explore more adaptive platforms or integrate real-time collaboration features to enrich student-to-student interactions. In conclusion, the implementation of this e-module demonstrates that the synergy between instructional technology and appropriate pedagogy can create a more humanistic, high-quality, and relevant physics learning experience, meeting the needs of today's digital transformation.

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